DOCUMENT RESUME

ED 254 917 EA 017 580

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TITLE Criterion Standards for Evaluating Computer Simulation Courseware.
PUB DATE Oct 84
NOTE 30p.; Paper presented at the Annual Meeting of the International Society for Educational Planning (New Orleans, LA, October 17-19, 1984).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; Computer Graphics; *Computer Managed Instruction; *Computer Simulation; *Computer Software; *Courseware; Educational Technology; Elementary Secondary Education; *Evaluation Methods; Microcomputers; Standards
IDENTIFIERS Decision Support Systems

ABSTRACT

This paper explores the role of computerized simulations as a decision-modeling intervention strategy, and views the strategy's different attribute biases based upon the varying primary missions of instruction versus application. The common goals associated with computer simulations as a training technique are discussed and compared with goals of application-oriented simulations. General issues related to the evaluation of general instructional computing systems are also identified, including 18 "clusters" of standards for evaluating curriculum linkage, documentation, CAI (computer-assisted instruction) elements, CMI (computer-managed instruction) elements, screen displays, student groupings, bolt requirements, range of student use, data directives/response input, user control flexibility, hardware requirements, user pretraining, teacher supervision, auxiliary motivation, reinforcement, student individualization, flow of program design, use of graphics, and error trapping. In addition, key focal points are identified that help the teacher adequately evaluate simulation courseware. Two pages of references are included. (TE)

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CRITERION STANDARDS FOR EVALUATING COMPUTER SIMULATION COURSEWARE

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Presented to the 1984 Annual Meeting of the
International Society of Educational Planners (ISEP)
New Orleans, Louisiana (October 1984)

ABSTRACT

Criterion references are explored for the evaluation of computer-assisted decisioning simulation software, and this software's use in the training of educational planners.

SUMMARY

While many general software and courseware evaluators have posited criteria for evaluating computer-assisted (CAI) and computer-managed (CMI) courseware, little has been accomplished in terms of criterion references for assessing the value and benefit derivable from the use of computer simulation software. This is especially true for those simulation software packages which could be utilized to train educational planners and program evaluators. The evaluation of computer simulation software (and courseware) will be explored in this paper from the perspective of identifying specific content-process standards which should be assessed in evaluating simulation software.

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D E D I C A T I O N

This project is dedicated to all policy analysts and program planners in education who have suffered through such tedious diatribes as:

01 "There is always a simple solution to a complex problem if you look hard enough.";

02 "Don't make a mountain out of a molehill.";

03 "You may understand what you are doing, but no one else does; and, unless you can make them understand exactly what you have done, the project must be abandoned.";

04 "I don't understand what you have done; therefore, it is no good.";

and finally,

05 "I was just trying to help."

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INTRODUCTION

The use of the computer for simulating likely effects (viz. consequences) based upon alternative tactical actions, and the strategies which support these actions, represents a highly valuable tool for educational planners. Especially in those case where the impact of higher level decisionmaking must be referenced within a highly fluid and transactional environment (system), computer simulations of decision models provide the planner with the potential to survey likely effects of proposed actions in advance of the actual execution and/or implementation of these actions. With the advent of microcomputers, such decisioning simulations are now more available as an analytical tool for the educational planner than ever before.

The term, educational planner, is actually a generic entity which has (at least) three sub-strata related to different types of planning performance -- types of performance which must be identified during training if the preparation of educational planners is to be effective and comprehensive. The first type of verifiable planning performance is that related to curriculum planning, development and validation. In this setting, the educational planner has priority interests in the instructional (teaching) mission of the school enterprise. A second type of verifiable performance is that of the 'policy analyst' planner. Such planning activities are usually associated with the need to detect likely consequences of different policy interpretations under varying conditions. The third type of planner is typically concerned with more 'tactical' activities, especially those related to specific problem missions which must be addressed immediately; for example, declining enrollments and school closures, program budget reductions, personnel termination, etc.

In this paper, we are most concerned with the role of computer simulation processes in preparing such planning specialists of the educational enterprise to cope effectively and efficiently with such problems as identified above -- the planners themselves utilizing simulation processes which facilitate decisional modeling functions.

With an ever increasing understanding of the value of decision modeling and impact simulations, coupled with the availability of computerized processes in the form of microcomputers, the graduate level training of the educational planning specialist can, and in many cases does, incorporate elements -- both theoretical and practical -- of decision modeling within the training curriculum of the planning discipline. Whether described as applications software due to its predominant use as an empirical field-based tool, or courseware because of its primary role for instruction, computer simulation programs lend a technological approach to the planning process, and therefore promote the necessary awareness that systems' planning (1) is a complex and highly structured process, (2) dealing with complex and highly interrelated subsytems, and (3) requiring complex and highly technical intervention techniques for designing and developing alternate resolution strategies.

Although simulation software have the potential to address either or both of the needs of application and instruction, the use of such software during field based applications will be different than its deployment as an instructional tool, exhibiting different attributes, and therefore requiring a different perspective on the part of an evaluator whose goal is to assess the relative strengths and weaknesses associated with the varying 'use potentials' of such software/courseware. As an instructional tool, decision-modeling/simulation courseware must be valid as a teaching medium in addition to its validity and reliability for empirically solving a problem. In contrast, field-based applications software need only perform the analysis task correctly, regardless of the user's potential to learn anything new 'academically' from such use, for the software application to be deemed successful.

In this paper, we will explore the role of computerized simulations as a decision modeling intervention strategy, and view its different attribute biases based upon the varying primary missions of instruction versus application. The common goals associated with computer simulations as a training technique will be discussed, and compared to those goals of application-oriented simulations. General issues related to the evaluation of general instructional computing systems will also be identified. Finally, specific standards (criteria) for

evaluating the potential of 'simulation software' as courseware will be presented.

The reader is cautioned that this paper is but a brief introduction to the content and process characteristics of (1) decision modeling software, and (2) its evaluation as an instructional medium. The conceptual perspective of computer simulations as a planning tool, and moreover the technique of software evaluation itself, are individual topics worthy of separate treatment. The valid and reliable deployment of decision-modeling/simulation as an educational planning tool, and its use for the teaching of educational planning specialists, are highly technical 'trades' which require specific, detailed study beyond the scope of this paper.

COMPUTERIZED SIMULATION, AND DECISION MODELING

The application of simulation techniques to problems of strategic planning and the tactical deployment of resources has for years been a highly accepted, technical feature associated with planning and evaluation efforts in business and industry. Beginning with the late 1960's moreover, similar techniques have attempted to incorporate their philosophical biases into elements of program planning and evaluation related to the educational enterprise. Unfortunately, education in its broad discipline role, when compared to other more specific disciplines as business administration, industrial engineering and political science, has failed to embrace the planning simulation or decision modeling philosophy as a desirable or even viable option when decisionmaking must take place in a highly variable, data based and systemic transactional environment.

Simulation, as a technical process, supports the philosophy that problem resolution is a complex activity requiring a highly structured approach for understanding (1) systemic interrelationships based upon subsystemic influences, (2) what alternative solutions are viable, (3) the likely impact of each of these alternatives upon the problem defined, and (4) transactional effects within the system as a whole based upon the alternative selected. To simulate means 'to test' alternative actions based upon what one knows about the problem,

the system within which the problem resides, the potential significance of alternate actions in resolving this problem, and other related effects upon the system which such solutions might effect during implementation. Simulation allows the program planner to employ basic assumptions about the environment of the problem, and the influence(s) of alternate solutions upon that problem as well as the environment within which the problem resides. From such a comprehensive understanding, likely effects of alternative decisions, i.e. alternate solutions, can be tested for their validity and reliability prior to actual empirical implementation (or execution).

The structuring of the problem-resident environment for decisioning simulation requires the construction of a model, typically of quantitative dimensions, allowing the planner to enter data regarding (1) the environment, (2) the context of the problem itself, and finally (3) intended (alternate) solution(s), and then receive information which suggests the likely impact which such an intended solution would have upon the problem in particular, and the environment within the problem resides in general. This 'model' is a collection of analytical statements which (1) interpret input data representing the problem, its environment, and the intended solution, (2) generate required information which allows for the comparison and contrast of effects from alternative solutions, and then (3) evaluate each alternative action for its feasibility as a solution in terms of pre-specified indices of criterion-based strengths and weaknesses.

Computer assisted simulation techniques require the planner to supply instructions associated with the 'process' of the simulation, i.e. how input data will be analyzed to model the problem, its environment, and the action which will be tested as a possible solution. Supplementary instructions will also be necessary to define what information is to be generated and then output to the planner as an annotated summary of comparative strengths and/or weaknesses associated with the particular solution being tested. Depending upon the particular software used, specific instructions regarding how such data will be input to the computer system are usually generic, and a priori defined.

Data input requirements, and the comprehensiveness and flexibility associated with these requirements, are of particular interest to educational plan-

ners when employing computer simulation techniques. Beyond the basal needs of entering data which identifies the various attributes of a particular action alternative, certain other data entry requirements exist which facilitate the decision modeling and simulation process. Such requirements include, but are often not limited to, the ability to:

01 establish conditions (i.e. interactions) pertinent to the decisional environment, and parameters (i.e. limits) germane to these environment interactions;

02 modify existing conditions and/or parameters based upon changing needs or predictive trends existent within the decisional setting;

03 query the impact of alternate activities (actions) upon the environment, including the identified problem, and based upon the particular alternative action being simulated and its effects upon associated criterion based indices;

04 assess the sensitivity of current solution(s) with respect to projected variability (changes) in established conditions and/or parameters for the future; and,

05 evaluate the significance, statistically and magnitudinally, of the results of a simulated decision for both adequacy of impact as well as appropriateness of effect.

The ability of a computer based simulation technique to achieve the above stated objectives, and provide a functional basis which facilitates the processes inherent in educational planning, will largely depend upon the capabilities of the computer software available to the planner.

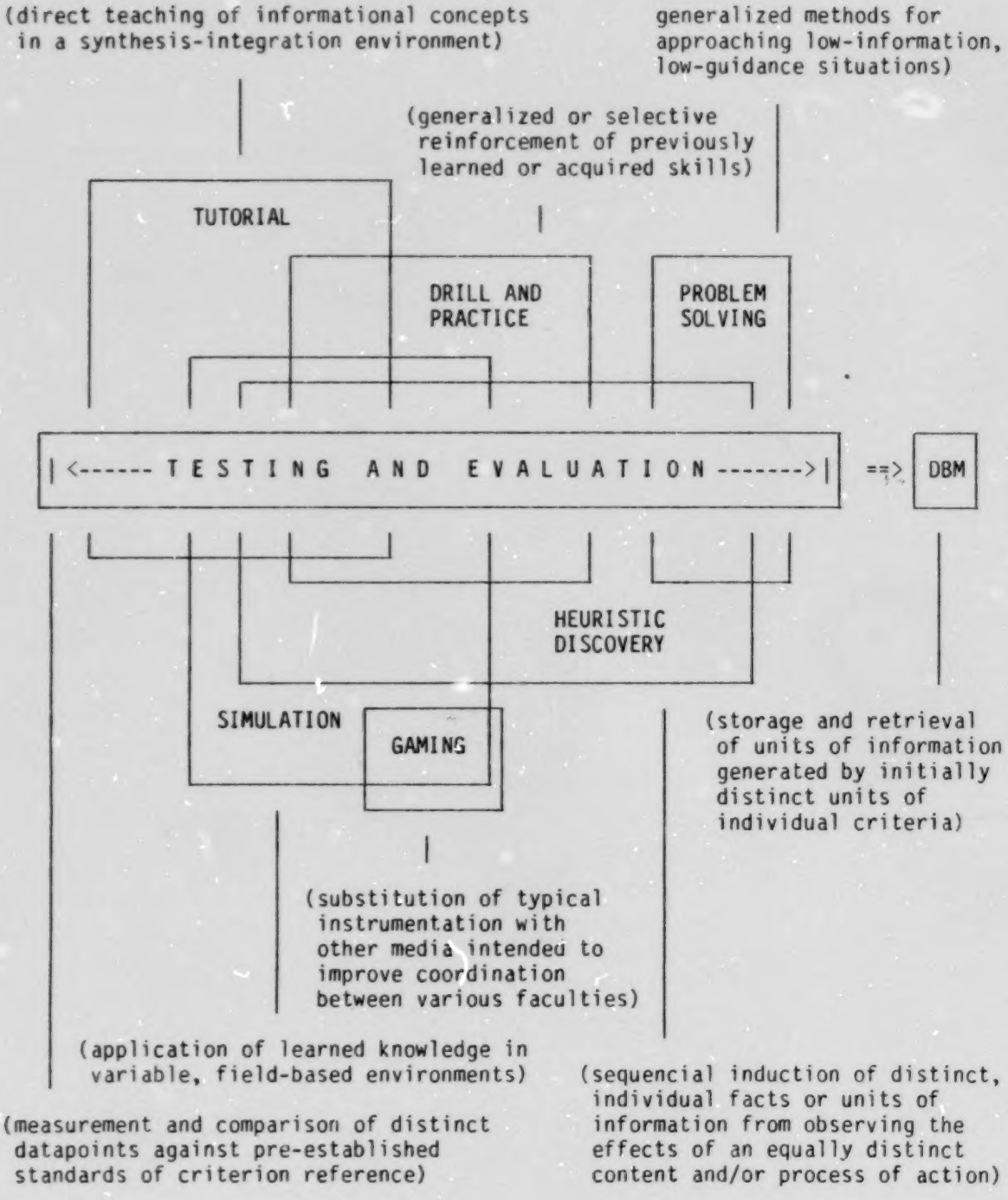
SOFTWARE APPROACHES TO COMPUTERIZED SIMULATION MODELING

Programmed instructions for computer-based decisioning simulations, have traditionally been of two types: generic programs which allow the modeler to design a computer simulation for several different types of simulations using the same software package (e.g. integer programming in operations research), and species oriented programs which are useful only for a discrete number of types of simulation problems (e.g. transportation networking). In addition, some software packages perform functions which can be used for simulations, but which are not necessarily simulation software. Software which, for example, perform statistical analyses (e.g. SPSS, Minitab, etc), or alternatively compute simple matrix multiplication operations, can indeed be used to conduct such simulation based processes as discriminant function analysis and Markov processes, respectively. Regardless of the focus of use for these various types of simulation software packages, each type must incorporate elements (viz. abilities) of data input, process and output described in the previous section.

Historically, simulation-utility software has seldom been evaluated for its particular usefulness in data analysis beyond the initial assessment of program code validity and run-time execution reliability, and subsequently for its flexibility or ease of model design and program development (viz. user friendliness). Basically, if it worked, it worked -- especially if the user knew how to employ the command syntax quickly and accurately (emphasis on the first criterion). The focus upon evaluation though is rapidly changing as decision-modeling/simulation software becomes increasingly a part of the curricular processes for training planning specialists as well as assisting the instructional processes of other types of discipline based teaching activities.

The teaching of decisional simulation as a planning and/or evaluation strategy, as well as the use of simulation for teaching other discipline-oriented content areas (e.g. educational administration, political science, chemistry, nuclear engineering, the social studies, and space technology), provide a myriad of opportunities to view how pervasive the use of simulation(s) can be for empirical, field-based research as well as classroom teaching. The following

diagram demonstrates how elements of simulation (and its distant-cousin, gaming) overlap with other, more traditionally accepted forms of instructional techniques.

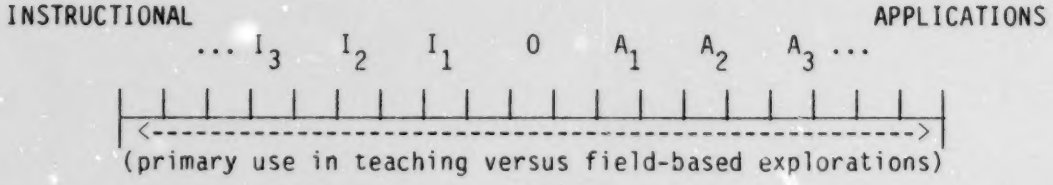

(direct teaching of informational concepts in a synthesis-integration environment)
generalized methods for approaching low-information, low-guidance situations)
(generalized or selective reinforcement of previously learned or acquired skills)
TUTORIAL
DRILL AND PRACTICE
PROBLEM SOLVING
<------ TESTING AND EVALUATION ------->
==>
DBM
HEURISTIC DISCOVERY
SIMULATION
GAMING
(storage and retrieval of units of information generated by initially distinct units of individual criteria)
(substitution of typical instrumentation with other media intended to improve coordination between various faculties)
(application of learned knowledge in variable, field-based environments)
(sequencial induction of distinct, individual facts or units of information from observing the effects of an equally distinct content and/or process of action)
(measurement and comparison of distinct datapoints against pre-established standards of criterion reference)

In terms of teaching, simulation provides the ability to reinforce a student's learning through the actual application of previously taught skills in a variable, field-based (i.e. simulated) environment. In terms of application, on the other hand, simulation provides the decisionmaker with the ability to test certain a priori assumptions against selected possible actions, with the opportunity to view likely results of such actions within the context of these assumptions. Like computer based, statistical analysis software packages, computer based simulation modeling software (in the applications sense) or courseware (in the teaching sense) provides unlimited opportunities for both teacher and learner. As instructional courseware however, simulation software packages assume somewhat different priorities in terms of their potential use.

COMMON GOALS OF COMPUTER SIMULATION COURSEWARE

While simulation software will normally function as instructional courseware in the classroom as well as applications software in the field, instructional simulation courseware must typically be more narrowly defined. In addition, some simulation based courseware, if in fact they could be used to approach real world (field based) problem settings, are usually limited because of such technical problems as the number, type and range of parameters and/or conditions necessary to model the problem environment adequately and appropriately.

The priorities for use of the simulation courseware, when originally developed and programmed, assesses the attributes of the software as falling somewhere along a continuum of high instructional versus high applications oriented:



For example, most computer software which performs simulation-related analyses for field-based applications can be used in the classroom for instructional

purposes, both in terms of demonstrating the utility of such an approach as well as training the student how to use that particular software package. On the other hand, more instructionally oriented software packages often can be utilized for field based applications, although many such packages are very limited in the size of problems they might effectively address. Other instructionally related packages are not germane to field based applications at all, and strive only to provide 'pseudo-reality' experiences to the student user. Such simulation packages typically fall into the category of simulation software often referred to as 'gaming' courseware.

As an instructional intervention tool, computer simulation courseware is often concerned with such common goals as:

01 to demonstrate relationships which exist within structured systems based upon interventions introduced within that environment, and the effect of those interventions;

02 to practice the technique of structured intervention within a strictly defined environment, observing the variable impact based upon varying focused interventions;

03 to review the results of well-defined interventions within a highly structured, transactional system, and the foundations for the validity and reliability of these results;

04 to study the effects of alternative actions, based upon certain criterion indices which signal strengths as well as weaknesses associated with each alternate tactic; and,

05 to experience the utility and style of distinct, controlled reactions based upon a structured intervention, and the predictable reliability of criterion based indices which assess the importance and/or significance of these reactions.

As an example of simulation-based courseware that is useful for instruction, consider the following illustrated mission:

> ESTABLISH A SYSTEM BY WHICH THE EMERGENCY MEDICAL TECHNICIAN (EMT) AND EMERGENCY CARE ATTENDANT (ECA) TRAINEE WILL BE PRESENTED WITH TYPICAL EMERGENCY SITUATIONS; AND THROUGH WHICH THE EMT AND ECA CAN SIMULATE THE LIKELY DECISIONS WHICH MAY BE APPROPRIATE IN SUCH SITUATIONS

including, though certainly not limited to, a desired satisfaction of the following underlying curricular goals:

> provide a simulated experience of cause and effect for the Emergency Medical Technician (EMT) and Emergency Care Attendant (ECA) in the provision of emergency treatment to the immediate environment of the emergency victim;
>
> promote a valid and reliable application of emergency situations wherein immediate emergency medical response is required; and where immediate feedback to the Emergency Medical Technician (EMT) and Emergency Care Attendant (ECA) trainee is both instructive and desirable; and,
>
> evaluate Emergency Medical Technician (EMT) and Emergency Care Attendent (ECA) trainee responses to various emergency situations in terms of both appropriateness and reasonableness; and to allow diagnostic and prescriptive assessments of such response trends.

Instructional courseware providing a simulated environment for fulfilling such a mission would necessarily include interaction(s) between the student user and the computer which would approximate both typical as well as atypical emergency scenes. Assuming an interactive, monitor/keyboard based system, several 'screen sequences' or templates would be required, including:

Screen 1: DISPATCH INFORMATION

Screen 2: OVERVIEW OF SCENE

Screen 3: INITIAL (PRIMARY) SURVEY OF VICTIM

Screen 4: INITIAL COMMUNICATION TO CENTRAL CONTROL

Screen 5: SECONDARY SURVEY OF VICTIM

Screen 6: CONDITION OF VICTIM'S VITALS

Screen 7: MECHANICS OF INJURY

Screen 8: VICTIM'S VITALS + TREATMENT RESPONSE

In this curricular context, the educational planner is concerned with the content and process characteristics of the teaching paradigm (simulation) and its medium (computerization). In addition, the ability of the student to internalize 'learned concepts' and 'experienced applications' must be identified, measured and validation for such the use of computer simulations to be considered effective.

In compliance with the stated mission -- as an illustration of the screen (information and response template) which would be deemed applicable for satisfying the underlying goals -- 'screen 8' will be illustrated.

SITUATION	(Screen segment flashes when situation varies or new information is made available.)
VITAL #1 - PULSE (Rate, Depth, Regularity)	(Individual vital-segment inverses display image if particular problem being presented is not rectified by respondent-proposed treatment.)
VITAL #2 - BLOOD PRESSURE (Systolic / Diastolic)	
VITAL #3 - RESPIRATION (Rate, Depth, Regularity)	(Individual vital-segment flashes when particular vital sign changes.)
VITAL #4 - SKIN COLOR	(Individual vital-segment provides information by displaying a relevant word, phrase, comment or set of numbers (as in the case of signifying blood pressure or rate of respiration. This information remains on the screen until changed by treatment, or until the victim's condition deteriorates.)
VITAL #5 - SKIN TEMPERATURE	
VITAL #6 - PUPIL REACTION	
VITAL #7 - LEVEL OF CONSCIOUSNESS	(In some instances, a change vital signs will ask the respondent if further information is desirable. A 'yes' response signals return to a brief tutorial or review module f/ study.)
VITAL #8 - REACTION TO PAIN	
VITAL # 9 - SENSATION / PARALYSIS	
TREATMENT RESPONSE TO SITUATION AND VITAL SIGNS 1. Independent Keyword Response by EMT 2. Multiple-Choice Answer to Inquiry 3. Dichotomous Yes/No Answer to Question	(Inappropriate response executes an immediate return to a pertinent remediation module.)

In contrast, computer simulation software, whose priorities lie in the use of computerized processes as a field-based, application tool, are more often concerned with such goals as:

01 to model the interactive influences of highly fluid and transactional environments, establishing cause-effect as well as highly correlated relationships under the control of that systemic domain;

02 to observe the content and process characteristics of predictable variable output(s) based upon projected variable input(s), and identify common interrelationships which signal predictable influences for future decisionmaking;

03 to evaluate the impact upon systemic operations of various alternative tactical actions and/or strategic policy guidelines, establishing the range of positive and negative influences which might result from alternate decisions and problem resolutions;

04 to contrast the effects of likely future trends upon organization or systemic functioning, based upon explainable relationships within the current operating system; and,

05 to value the impact upon the system of variable alternative strategies, based upon the limits of a constrained environment, and the differential impact upon that environment which the relaxation or restriction of those constraints might foster.

Consider a decision modeling illustration where computer simulation is used to assist educational planners in the problem context of declining enrollments and school closures. In this setting, the planner -- compleat with whatever data and other information can be identified and gathered -- attempts to use a decisional simulation approach to identifying which school, if any, should be closed in the face of enrollment declines, and the likely impact to the school district based upon such closure(s). That is:

TARGET THE NECESSARY NUMBER OF SCHOOL CAMPUSES IN THE SCHOOL DISTRICT FOR FUTURE OPERATIONAL DISCONTINUANCE OR CONTINUANCE AND THE SPECIFIC LEVEL OF THAT DIS/CONTINUANCE, RESPECTIVELY

[choosing from three pre-evaluated options for closure (i.e. including sale, leasing or mothballing) and two options for operational continuance (functional partitioning with sub-site leasing and full program continuance (no change))]

subject to:

maximizing the positive influence from all schoolbased programs, and their support administrative and physical plant structures, on total school district functioning, based upon final school-by-school closure levels selected;

minimizing the negative influence from all schoolbased programs, and their support administrative and physical plant structures, on total school district functioning, based upon final school-by-school closure levels selected;

assuring that all schools and their programs within the school district are nondiscriminantly evaluated, compared and constrasted to ascertain their contributing value or worth to the goals of the school district as a whole; and,

targeting conclusively levels of operational dis-continuance or continuance based upon valid measures of effectiveness, expenditure, economy, efficiency, and satisfaction pertinent to the character of each school, and its instructional mission.

To accomplish this intent, a reformulation of the multiple alternatives modeling™ framework (Wholeben, 1980) for hierarchical decisionmaking will be briefly illustrated. Within the MAM™ context, the operational alternatives for each school are delineated into five (5) closure/non-closure options depending upon a pre-modeling evaluation of each school, and the resulting school options scenarios or narratives which result. Criteria, in the form of numerical vectors, are introduced within the model to (1) simulate the decisional environment of the school district, its various service programs and instructional departments, (2) depict the strengths and limitations associated with each 'school closure' alternative, and (3) compete for influence in the comparison and constrast of each 'closure' alternative with other likely options.

Alternative-j (j=1,...,n) ==> School Campus/Site				
Option-1	Option-2	Option-3	Option-4	Option-5

where: Option-1 = target the site for future closure, and prepare the buildings for sale and future relinquishment of district control;

Option-2 = target the site for future closure, and prepare the buildings for lease under district control;

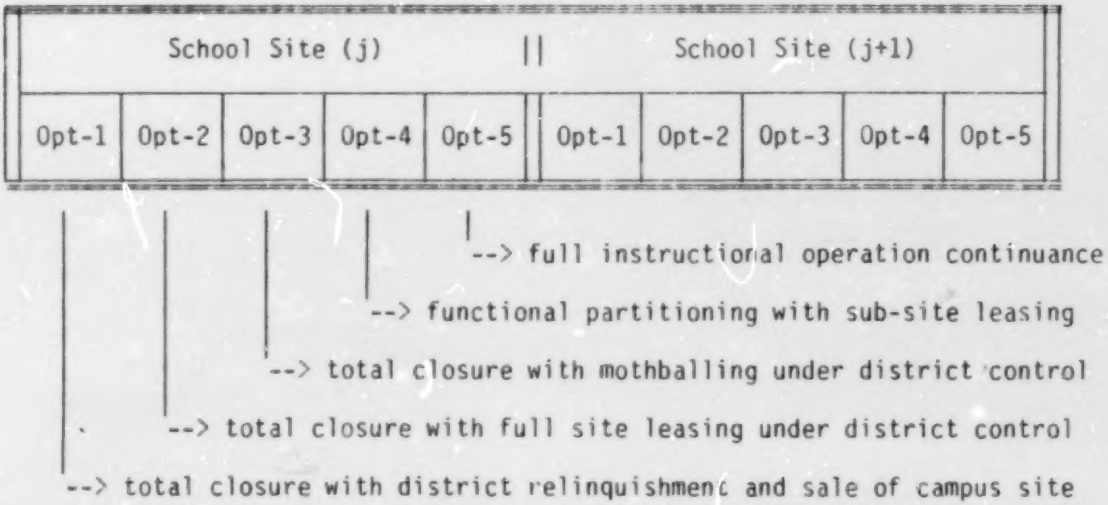
Option-3 = target the site for future closure, and prepare the buildings for 'mothballing';

Option-4 = target the site for functional partitioning with partial physical units of the campus for sub-site lease; and,

lease; and,

Option-5 = target the site for continued full operation as an instructional services center.

The importance in defining the structure of these alternatives is better understood when different higher-order alternatives (i.e. the schools) are also contrasted along with the lower-order alternatives (i.e. level of discontinuance or continuance). Note the interaction in the following figure.



Based upon the type(s) and quantities of data entered by the user, this type of simulation-related software analyzes (compares and contrasts) the relationships between the schools under evaluation for closure, and then targets those sites for closure which best serve the interests of the district, based upon other types of data based information generated by this decision model. Such a simulation based setting would be useful in the classroom as a teaching device in addition to its use in the field.

Whether the main priorities for a computer simulation software package lie in the area of instruction or field-based, empirical applications, simulation processes must address each of the seven (7) general categories of: mission, system, relationships, alternatives, effect, solution and impact -- as a careful reading of each of the preceding 10 goals of instructional and applications use will attest. Differences inherent in the varying use of such software lie in 'how' each of these categories is defined or construed during such use. These differences might be viewed as follows:

INSTRUCTIONAL		APPLICATIONS
(defined)	MISSION	(formulated)
(closed)	SYSTEM	(open)
(predictable)	RELATIONSHIPS	(unpredictable)
(finite)	ALTERNATIVES	(infinite)
(discrete)	EFFECTS	(variable)
(academic)	SOLUTION	(optimal)
(intra-systemic)	IMPACT	(extra-systemic)

With this comprehensive albeit brief background regarding computer simulation software/courseware, we are now prepared to approach the evaluation process in two stages. First, we will be concerned with the overall assessment of the instructional computing environment, both hardware as well as software, but only in general terms. Secondly, our concern will be directed more specifically towards evaluative indices specifically germane to the evaluation of courseware which are simulation modeling based.

ISSUES IN THE EVALUATION OF INSTRUCTIONAL COMPUTING SYSTEMS

Recent research efforts have identified a minimum of 107 individual categories of criterion standards with which computer-assisted instructional (CAI) courseware might be evaluated. (See: Evaluation Criteria for Computer Assisted Instructional Components (Wholeben, 1984).) Although these findings are not yet ready for publication release, and furthermore that these findings are multidisciplinary in source, the 18 clusters of criterion reference suggested by these 107 categories can be discerned for the benefit of the reader.

These clusters of courseware evaluation foci, and their respective meanings, seek to determine the extent to which the courseware maintains an ability to:

CURRICULUM LINKAGE
interface with the established syliabic guidelines of the course, and the current written and A-V materials already in use

DOCUMENTATION
provide readable instructions for facilitating the optimal use of the computer (hardware and software), and its application as an instructional tool for student learning

CAI ELEMENTS
correlate with each of the 12 elements of computer-assisted instruction, dependent upon the primary mission of the course-ware itself, and its intended role in the classroom

CMI ELEMENTS
correlate with each of the 12 elements of computer-managed instruction, especially in the control and management of the individualized student learning episode

SCREEN DISPLAYS
transfer the maximal amount of information to the student user regarding concepts and skills, application, and individual achievement and progress

STUDENT GROUPINGS
provide instructional utility not necessarily limited to the use of a single student on a single system

BOOT REQUIREMENTS
program individual student workstations, and respond to individual student requests, with or without the constant presence of the program's input medium

RANGE OF STUDENT USE
support a wide array of student needs, varying from individual characteristics of age, grade-level, and current performance and/or ability limits of the individual student's cognitive domain

DATA DIRECTIVES/RESPONSE INPUT
provide efficient and timely access to memory for entry and modification of conditions/parameters governing the execution of the program

USER CONTROL FLEXIBILITY
allow a student's open-entry/open-exit perogative(s) for continued use of courseware under variable time scheduling

HARDWARE REQUIREMENTS
type, amount and alternate system configurations required for supporting the software and its instructional needs

USER PRE-TRAINING
promote use of the instructional computing system without inordinate pre-use training of either the teacher or the student

TEACHER SUPERVISION
minimize the amount of direct supervision required by the teacher as the student proceeds with system use

AUXILIARY MOTIVATION
utilize such aspects of data processing as color, sound, animation, and variable video screen format displays for enhancing user motivation

REINFORCEMENT
apply both positive as well as negative responses to student input and progress in adequate, useful and appropriate ways

STUDENT INDIVIDUALIZATION
sensitize various aspects of the program and its functioning to the individual needs and learning differences of the student user

FLOW OF PROGRAM DESIGN
follow acceptable standards of cognitive and psychological learning paradigms for the transfer of concepts and their underlying skills

USE OF GRAPHICS
utilize schematic and other pictorially related styles of information exchange in lieu of textual processes

ERROR TRAPPING
prevent the user from unintended or premeditative, premature aborting of the program's operation

The above 18 criterion clusters have been found to be most important in the evaluation of instructional computing courseware, and can be applied to most of the domain categories of instructional computing for successfully assessing the comparative utility of alternative courseware packages.

Of particular interest for the training of educational planners, however, are those uses of simulation courseware for effectively teaching not only concepts and skills related to those concepts but also the step-by-step application of these skills to relevant real-world problems or situations. For these

reasons, the case of simulation-based courseware will be treated in greater detail.

STANDARDS FOR COMPUTER SIMULATION COURSEWARE EVALUATION

Simulation-based courseware utilizes the computerized environment to interact with a student in a reality-based orientation. Simply stated, the student makes decisions and enters appropriate data relative to these decisions, in response to which the computer analyzes the probable impact of such decisions in a controlled though quasi real-life situation, and then provides feedback to the student as to what impact such a decision would have 'really' had in a real-life milieu. Such real-life situations might range from variable product import-export relationships, to the political science bases of arms negotiations.

In general, several key points of criterion focus can be identified which will help the teacher adequately evaluate simulation courseware. These points are in addition to the 18 clusters already presented in the last section, and extend the need(s) for the courseware to possess seven (7) specific abilities.

- **PRESENT A CONCISE, CLEAR SITUATIONAL CONTEXT FOR THE SIMULATION WHICH IS LEARNING-BASED RATHER THAN GAMING-BASED;**

Although instructional simulations can be intrinsically entertaining, especially those very skewed in terms of their mission of teaching priority, the amount of student learning achieved is the final indicator of efficacy. The context of the 'situation modeled' must be clear at the beginning, so that the user understands the environment in which decisions will be made, and thereby better understands the reactions of the system based upon these decisions. Such demands will typically require that a student's responses be cumulative, that is, once a decision is performed, all subsequent responses from the system to the student include the results of these precedent judgements.

* PROVIDE A CLEAR INDICATION OF VARIABLES AND CONSTANTS, THE EXTENT TO WHICH THESE VARIABLES ARE USER VERSUS PROGRAM CONTROLLED, AND THE RELATIONSHIP BETWEEN THESE TWO TYPES OF VARIABLES;

Although empirical reality is seldom as predictable as planners might like, instructionally based simulations must be predictable in terms of their responses and/or reactions to student decisional inputs, if the student is to learn and prosper from such reactions. Student understanding is facilitated through as clear an understanding as possible, initially, of those variables which the simulation entertains as analytical apart from those measures which are always in effect as constants. Subsequently, the student must understand which of the variables can be directly controlled (i.e. measures input) by the student from the keyboard, and which measures will be generated by the simulation in response to student input via other variables. Finally, student knowledge concerning how such variables relate to each other fosters a learning environment which increasingly makes subsequent reactions of the environment predictable. During subsequent instructional simulation episodes, the student can be given less information, progressively, and encouraged to developed personal perceptions related to the interrelationships existent within the problem environment under study.

* PROMOTE AN ACCEPTABLE LEVEL OF PERSONAL INTEREST ON THE PART OF THE STUDENT USER VIA THE VIDEO DISPLAY SCREEN FORMAT, ESPECIALLY IN TERMS OF COMPREHENSIVENESS, EFFECTIVENESS AND EFFICIENCY OF INFORMATION DISPLAY;

Similar to other forms of 'physical' documentation, the screen display should be clear and concise, making available whatever information the student needs in order to refine previous judgements and/or modify subsequent data input demands of the system. Although the student should be required to make specific demands of the systems for specific information, such information when output should be easily interpreted to facilitate the student's continued use of the decisional simulation.

° ALLOW AN ON-DEMAND LINKAGE TO TUTORIAL MODE, PROVIDING ADDITIONAL INFORMATION WHY CERTAIN EFFECTS CAN BE EXPECTED BASED UPON THE STUDENT'S CHOICE OF ACTION OR INACTION, AND FURTHERMORE WHAT MIGHT HAVE BEEN A WISER RESPONSE BASED UPON CURRENTLY RECORDED CONDITIONS;

Simulation courseware must be first and foremost didactic in nature, and therefore promote an environment in which the student learns from simulated experiences. When the student, for example, feels that any further judgements concerning data input would be little more than mere guessing, the student should have the ability to ask the system (1) "What might I do next?", and (2) "Why?". In addition, if the system responds to a decision with a negative reaction, and the student fails to understand the validity of this reaction, means should be available to query the system for an extended exp'anation of rationale.

° GRADUATE THE PROGRAM'S SITUATIONAL COMPLEXITY AND RESPONSE ATTRIBUTES BASED UPON A 'NOVICE ... EXPERT' CONTINUUM, ALLOWING BEGINNING USERS MORE STRUCTURE DURING THE INITIAL LEARNING PROCESS WHILE PROVIDING SEASONED USERS WITH MORE COMPLICATED SIMULATION PROBLEMS;

Since computerized processes provide the potential for individual students to proceed individually through the teaching-learning paradigm, the ability of instructional simulation programs to 'start simple' and become progressively more difficult based upon a student's individual performance trends is considered important.

° VARY THE TYPES OF RESPONSE-FRAMEWORKS (USER RESPONSE OR QUERIES) TO BETTER APPROXIMATE REAL-LIFE SITUATIONS (E.G. DICHOTOMOUS, KEYWORD, FORCED-CHOICE, DIRECTIONAL AND SHORT-RESPONSE);

The key to experiential learning through computerized decision-modeling simulations can be attributed to the need of the student to interpret new information output as it transpires -- that is, respond to new information based upon a progressive understanding of the system under simulation. By varying how such information is presented to the user, and how the user must respond to differing situations, the simulation system provides a realistic context to problem solving which approximates real life situations.

° COORDINATE A STANDARDIZATION OF PROCESS (DISPLAY, RESPONSE, ETC.) WHICH ALLOWS THE STUDENT TO LEARN CAUSE-EFFECT RELATIONSHIPS WITHOUT UNDUELY COMPLICATING THE INTERACTION WITH SEEMINGLY AT-RANDOM OCCURRENCES.

Corollary to the previous criterion, a variance in response or reaction frameworks, and the student response to that framework, should not become so random as to defeat the initial priority mission of the simulation, that of instruction and student learning. Without a standard structure to the computer simulation, many students would be unable to interpret the underlying concepts and theories presented for learning consumption.

THE FUTURE OF INSTRUCTIONAL MODELING SIMULATIONS

Computerized instructional modeling in education, especially in terms of a computer simulation approach to decision modeling in the preparation of professional administrators, has yet to be accepted as a valid training technique for aspiring educational planners. The seeming complexity in its approach, the lack of understanding on the part of trainers, the reluctance to embrace any approach which is quantitatively oriented, and the general fear of computers themselves -- cumulatively militate against the acceptance of such simulations as viable teaching tools. Recently however, such reluctance has generally eroded through the increasing acceptance of the computer as an effective and efficient data analysis and information processing device. Familiarity with the physical device or hardware is rapidly leading to a better acceptance of the use of that device (i.e. its software) for heretofore unaddressable problems in the educational enterprise.

Similar to other advances in education over the past quarter century, real dangers lie in the application of this tool in the work setting before the tool's users have been adequately trained in its application(s). It is the role and responsibility of higher education professions to assure that such pre-use training is available. It is widely accepted that computer assisted instruction in the elementary and secondary classrooms has emerged relatively unplanned in its application and uncontrolled in its implementation. The use of the computer to (1) train educational planners, as well as (2) provide a valid and reliable

tool with which to perform planning, now courts these same dangers at the administrative level of the schooling enterprise.

From the instructional perspective, computerized simulations of decisional modeling settings is an effective tool in the hands of the trained professional. It is a weapon in the hands of all others. Without an understanding of the use of this tool, and the attributes of the software which direct its use, the training of educational planners for the future problems of education is void.

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